

## M.2.4 RADIOPHYSICAL IMPACTS AT HANFORD SITE

This section presents the radiological impacts of the various storage and disposition alternatives at Hanford. Section M.2.4.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section M.2.4.2 presents the radiological releases and resulting impacts from the various alternatives.

For purposes of radiological impact modeling, Hanford was divided into seven separate areas which would release radioactivity in 2005. All potential release points in each area were aggregated into a single release point. Table M.2.4-1 presents the characteristics of each of the release points including location, release height, minimum distance, and annual average dispersion to the site boundary in each of 16 directions. In order to calculate the maximum site boundary dose (that is, the dose ultimately incurred to the site MEI), the dose from each release point to the "maximum receptor" (that is, potential MEI) associated with each of the other release points has been calculated. For further clarification on the definition of a "maximum receptor" refer to Section M.2.2.2. For example, the dose resulting from releases from the 100 Area, 200 West, 200 East, 300 Area, and the other storage and disposition alternatives (Washington Nuclear Power-1), has been determined for the maximum receptor from the 400 Area. Figure M.2.4-1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose (that is, the dose ultimately incurred by the MEI) is then determined by the maximum dose to one of these maximum receptors. Table M.2.4-2 presents the distance, direction, and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the full operational period.

Descriptions of population, food stuffs distributions, and aquatic foods for each release area are provided in a Health Risk Data report, October, 1996. The joint frequency distributions used for the dose assessment were based on measurements from the meteorological tower in the 200 East Area at the 10-m (33-ft) height during the time period of July 1, 1989 through August 30, 1990 and is contained in the Health Risk Data report.

Doses given in this section are associated with 1 year of operation because regulatory standards are given as annual limits. The health effects are presented on an annual basis in the tables, and for the projected operational period in the text. Tables M.2.4-3 through M.2.4-6 include the radiological impacts to the public from both atmospheric releases and from using the surface water for No Action and the storage and disposition alternatives.

### M.2.4.1 No Action

**Atmospheric Releases and Resulting Impacts to the Public.** For No Action, five of the six areas have radioactive releases into the atmosphere from normal operation. Table M.2.4.1-1 presents the estimated annual atmospheric radioactive releases.

Tables M.2.4-3 and M.2.4-4 include the atmospheric radiological impacts to the maximally exposed member of the public and the offsite population within 80 km (50 mi), respectively. The MEI would receive an annual dose of  $4.4 \times 10^{-3}$  mrem. An estimated fatal cancer risk of  $1.1 \times 10^{-7}$  would result from 50 years of operation. The population within 80 km (50 mi) would receive a dose of 0.46 person-rem in 2030 (midlife of operation). An estimated 0.012 fatal cancers could result from 50 years of operation.

**Liquid Releases and Resulting Impacts to the Public.** For No Action, some areas may have radioactive releases to the offsite surface water from normal operation. Table M.2.4.1-2 presents the estimated annual liquid radioactive releases.

Tables M.2.4-5 and M.2.4-6, respectively, include the radiological impacts to the MEI and the offsite populations using surface water within 80 km (50 mi) downstream of Hanford. The maximally exposed member of the public would receive an annual dose of  $9.5 \times 10^{-4}$  mrem. An estimated fatal cancer risk of

**Table M.2.4-1.** Release Point Characteristics, Direction, Distance, and Chi/Q at the Hanford Site Boundary

Release Point <sup>a</sup>	100 Area		200 West		200 East		300 Area		400 Area		600 Area		WNP-1		
	Latitude	46°39'55.88"	Longitude	46°33'22.33"	Latitude	46°33'22.33"	Longitude	46°22'14.09"	Latitude	46°26'2.31"	Longitude	46°23'37.94"	Latitude	46°27'58.01"	
Release Height	12.8 m	Release Height	61.0 m	Release Height	61.0 m	Release Height	17.9 m	Release Height	14.3 m	Release Height	Ground Level	Release Height	Ground Level	Release Height	Ground Level
<b>Distance and Atmospheric Dispersion at Site</b>															
Boundary	Direction	Distance (m)	Chi/Q ( $\text{s/m}^3$ )												
N	8,727	$4.0 \times 10^{-8}$	17,234	$4.6 \times 10^{-9}$	22,325	$3.4 \times 10^{-9}$	9,361	$2.8 \times 10^{-8}$	16,086	$1.5 \times 10^{-8}$	38,245	$5.7 \times 10^{-9}$	10,853	$3.1 \times 10^{-8}$	
NNE	12,004	$2.1 \times 10^{-8}$	24,489	$2.2 \times 10^{-9}$	25,670	$2.1 \times 10^{-9}$	2,388	$1.3 \times 10^{-7}$	12,934	$1.6 \times 10^{-8}$	30,461	$6.4 \times 10^{-9}$	7,855	$4.0 \times 10^{-8}$	
NE	17,712	$2.2 \times 10^{-8}$	26,784	$3.6 \times 10^{-9}$	20,224	$4.9 \times 10^{-9}$	1,587	$3.7 \times 10^{-7}$	9,821	$4.2 \times 10^{-8}$	25,390	$1.4 \times 10^{-8}$	5,295	$1.2 \times 10^{-7}$	
ENE	20,510	$2.8 \times 10^{-8}$	24,022	$6.2 \times 10^{-9}$	17,492	$8.7 \times 10^{-9}$	1,413	$6.5 \times 10^{-7}$	7,922	$8.6 \times 10^{-8}$	22,039	$2.7 \times 10^{-8}$	4,865	$2.2 \times 10^{-7}$	
E	20,590	$4.6 \times 10^{-8}$	23,513	$9.1 \times 10^{-9}$	17,205	$1.3 \times 10^{-8}$	1,407	$9.4 \times 10^{-7}$	7,817	$1.4 \times 10^{-7}$	7,861	$1.8 \times 10^{-7}$	4,216	$4.5 \times 10^{-7}$	
ESE	22,165	$4.3 \times 10^{-8}$	28,561	$8.5 \times 10^{-9}$	22,180	$1.1 \times 10^{-8}$	1,492	$9.8 \times 10^{-7}$	7,846	$1.5 \times 10^{-7}$	5,867	$2.8 \times 10^{-7}$	4,212	$4.5 \times 10^{-7}$	
SE	31,482	$2.2 \times 10^{-8}$	24,266	$9.1 \times 10^{-9}$	26,251	$8.4 \times 10^{-9}$	1,883	$6.9 \times 10^{-7}$	8,746	$1.1 \times 10^{-7}$	2,748	$7.2 \times 10^{-7}$	5,313	$2.7 \times 10^{-7}$	
SSE	32,668	$8.5 \times 10^{-9}$	20,740	$5.7 \times 10^{-9}$	21,058	$5.6 \times 10^{-9}$	2,147	$2.8 \times 10^{-7}$	9,120	$4.2 \times 10^{-8}$	2,266	$4.1 \times 10^{-7}$	7,248	$7.0 \times 10^{-8}$	
S	26,544	$1.6 \times 10^{-8}$	14,929	$9.8 \times 10^{-9}$	19,177	$7.4 \times 10^{-9}$	2,137	$3.5 \times 10^{-7}$	7,915	$6.9 \times 10^{-8}$	2,225	$5.7 \times 10^{-7}$	12,429	$4.5 \times 10^{-8}$	
SSW	25,867	$8.7 \times 10^{-9}$	15,132	$5.3 \times 10^{-9}$	16,507	$4.8 \times 10^{-9}$	2,241	$1.8 \times 10^{-7}$	7,482	$4.1 \times 10^{-8}$	2,841	$2.1 \times 10^{-7}$	12,298	$2.5 \times 10^{-8}$	
SW	17,092	$7.2 \times 10^{-9}$	14,979	$3.7 \times 10^{-9}$	17,560	$3.0 \times 10^{-9}$	2,560	$8.5 \times 10^{-8}$	7,422	$2.0 \times 10^{-8}$	2,626	$1.2 \times 10^{-7}$	12,393	$1.2 \times 10^{-8}$	
WSW	15,068	$7.9 \times 10^{-9}$	12,638	$4.0 \times 10^{-9}$	19,118	$2.4 \times 10^{-9}$	3,677	$4.6 \times 10^{-8}$	12,536	$9.0 \times 10^{-9}$	3,709	$6.4 \times 10^{-8}$	17,723	$6.5 \times 10^{-9}$	
W	10,665	$2.7 \times 10^{-8}$	12,346	$8.9 \times 10^{-9}$	18,701	$5.3 \times 10^{-9}$	5,874	$5.1 \times 10^{-8}$	19,209	$1.1 \times 10^{-8}$	4,804	$1.2 \times 10^{-7}$	25,540	$8.5 \times 10^{-9}$	
WNW	8,593	$3.2 \times 10^{-8}$	12,546	$6.9 \times 10^{-9}$	18,995	$4.1 \times 10^{-9}$	27,312	$5.3 \times 10^{-9}$	33,445	$4.5 \times 10^{-9}$	6,527	$5.0 \times 10^{-8}$	37,072	$4.5 \times 10^{-9}$	
NW	7,289	$7.9 \times 10^{-8}$	14,910	$9.9 \times 10^{-9}$	19,803	$7.1 \times 10^{-9}$	46,357	$5.2 \times 10^{-9}$	38,932	$7.2 \times 10^{-9}$	23,021	$1.7 \times 10^{-8}$	38,585	$8.3 \times 10^{-9}$	
NNW	7,399	$7.3 \times 10^{-8}$	15,721	$8.0 \times 10^{-9}$	19,540	$6.2 \times 10^{-9}$	47,598	$4.7 \times 10^{-9}$	39,255	$6.7 \times 10^{-9}$	33,663	$9.5 \times 10^{-9}$	36,707	$8.5 \times 10^{-9}$	

<sup>a</sup> See Figure M.2.4-1 for location of release points.

Note: Release from the 600 Area are conservatively assumed to be near Rattlesnake Mountain.

Source: HNUS 1996a.

**Table M.2.4–2. Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at the Hanford Site Boundary**

Maximum Receptor For	Direction	Distance (m)	Atmospheric Dispersion Chi/Q (s/m <sup>3</sup> )
<b>Release Point: 100 Area</b>			
100 Area	NW	7,289	$7.9 \times 10^{-8}$
200 West	W	12,214	$2.3 \times 10^{-8}$
200 East	ESE	23,726	$3.9 \times 10^{-8}$
300 Area	SE	42,124	$1.5 \times 10^{-8}$
400 Area	SE	37,783	$1.8 \times 10^{-8}$
600 Area	S	32,656	$1.2 \times 10^{-8}$
WNP-1	SE	34,885	$1.9 \times 10^{-8}$
<b>Release Point: 200 West</b>			
100 Area	N	17,235	$4.6 \times 10^{-9}$
200 West	NW	14,910	$9.9 \times 10^{-9}$
200 East	E	23,514	$9.1 \times 10^{-9}$
300 Area	SE	35,271	$6.0 \times 10^{-9}$
400 Area	ESE	32,194	$7.5 \times 10^{-9}$
600 Area	SSE	22,149	$5.3 \times 10^{-9}$
WNP-1	ESE	30,381	$7.9 \times 10^{-9}$
<b>Release Point: 200 East</b>			
100 Area	NNW	19,541	$6.2 \times 10^{-9}$
200 West	WNW	19,965	$3.9 \times 10^{-9}$
200 East	E	17,205	$1.3 \times 10^{-8}$
300 Area	SE	30,363	$7.1 \times 10^{-9}$
400 Area	SE	26,701	$8.2 \times 10^{-9}$
600 Area	S	20,407	$6.9 \times 10^{-9}$
WNP-1	ESE	34,885	$6.9 \times 10^{-9}$
<b>Release Point: 300 Area</b>			
100 Area	NW	48,259	$4.9 \times 10^{-9}$
200 West	NW	48,764	$4.9 \times 10^{-9}$
200 East	N	23,223	$8.4 \times 10^{-9}$
300 Area	ESE	1,493	$9.8 \times 10^{-7}$
400 Area	NNE	5,963	$4.0 \times 10^{-8}$
600 Area	W	18,045	$1.1 \times 10^{-8}$
WNP-1	N	10,083	$2.5 \times 10^{-8}$

**Table M.2.4-2. Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at the Hanford Site Boundary—Continued**

Maximum Receptor For	Direction	Distance (m)	Atmospheric Dispersion Chi/Q (s/m <sup>3</sup> )
<b>Release Point: 400 Area</b>			
100 Area	NW	38,933	$7.2 \times 10^{-9}$
200 West	NW	39,581	$7.0 \times 10^{-9}$
200 East	N	16,127	$1.5 \times 10^{-8}$
300 Area	SE	10,547	$8.3 \times 10^{-8}$
400 Area	ESE	7,846	$1.5 \times 10^{-7}$
600 Area	WSW	13,655	$8.0 \times 10^{-9}$
WNP-1	ENE	8,188	$8.2 \times 10^{-8}$
<b>Release Point: 600 Area</b>			
100 Area	NNW	36,551	$8.6 \times 10^{-9}$
200 West	NNW	33,674	$9.5 \times 10^{-9}$
200 East	NE	25,978	$1.4 \times 10^{-8}$
300 Area	E	21,313	$4.6 \times 10^{-8}$
400 Area	E	21,493	$4.6 \times 10^{-8}$
600 Area	SE	2,748	$7.2 \times 10^{-7}$
WNP-1	ENE	22,418	$2.6 \times 10^{-8}$
<b>Release Point: WNP-1</b>			
100 Area	NW	38,611	$8.3 \times 10^{-9}$
200 West	NNW	40,473	$4.0 \times 10^{-9}$
200 East	N	12,370	$2.6 \times 10^{-8}$
300 Area	SSE	11,643	$3.5 \times 10^{-8}$
400 Area	SE	6,472	$2.0 \times 10^{-7}$
600 Area	WSW	18,493	$6.2 \times 10^{-9}$
WNP-1	E	4,216	$4.5 \times 10^{-7}$

Source: HNUS 1996a.

$2.4 \times 10^{-8}$  would result from 50 years of operation. The population would receive a dose of 1.1 person-rem in 2030. An estimated 0.028 fatal cancers could result from 50 years of operation.

**Worker Doses and Health Effects.** Based on measured values during 1991 and 1992, it is estimated that the average dose to a badged worker involved in No Action activities at Hanford in 2005 and beyond would equal 27 mrem. It is projected that in 2005 and beyond, there would be 9,300 badged workers involved in No Action activities. The annual dose among all these workers would equal 250 person-rem. From 50 years of operation, an estimated fatal cancer risk of  $5.5 \times 10^{-4}$  would result to the average worker and 5.1 fatal cancers could result among all workers.

**Table M.2.4-3. Doses and Resulting Health Effects to the Maximally Exposed Individual at Hanford Site From Atmospheric Releases Associated With Annual Normal Operation**

Alternative/Facility	Dose by Pathway (mrem)					Estimated 1-Year Fatal Cancer Risk
	Inhalation	Ingestion	Plume	Immersion	Ground Shine	
No Action (Total Site)	$9.9 \times 10^{-4}$	$2.9 \times 10^{-3}$	$4.2 \times 10^{-4}$	$1.4 \times 10^{-6}$	$4.4 \times 10^{-36}$	$1.5 \times 10^{-3}$
Upgraded Storage Facility-200 West <sup>c</sup>	$3.9 \times 10^{-7}$	$8.5 \times 10^{-9}$	$2.3 \times 10^{-15}$	$3.4 \times 10^{-12}$	$4.0 \times 10^{-7}$	$2.2 \times 10^{-9}$
Upgraded Storage Facility-Fuels and Materials Examination Facility <sup>c</sup>	$1.7 \times 10^{-6}$	$3.8 \times 10^{-8}$	$1.0 \times 10^{-14}$	$1.6 \times 10^{-11}$	$1.8 \times 10^{-6}$	$2.0 \times 10^{-13}$
Consolidated Storage Facility	$2.5 \times 10^{-6}$	$4.4 \times 10^{-9}$	$9.6 \times 10^{-16}$	$2.0 \times 10^{-12}$	$2.5 \times 10^{-6}$	$9.0 \times 10^{-13}$
Collocated Storage Facility	$2.5 \times 10^{-6}$	$4.4 \times 10^{-9}$	$1.0 \times 10^{-15}$	$3.0 \times 10^{-12}$	$2.5 \times 10^{-6}$	$1.2 \times 10^{-12}$
Pit Disassembly/Conversion Facility	$2.8 \times 10^{-4}$	$6.3 \times 10^{-6}$	$1.6 \times 10^{-12}$	$2.5 \times 10^{-9}$	$2.9 \times 10^{-4}$	$1.4 \times 10^{-10}$
Pu Conversion Facility	$1.8 \times 10^{-4}$	$3.4 \times 10^{-7}$	$7.7 \times 10^{-14}$	$1.6 \times 10^{-10}$	$1.8 \times 10^{-4}$	$9.0 \times 10^{-11}$
MOX Fuel Fabrication Facility	$1.4 \times 10^{-4}$	$2.4 \times 10^{-7}$	$5.2 \times 10^{-14}$	$2.5 \times 10^{-10}$	$1.4 \times 10^{-4}$	$7.0 \times 10^{-11}$
Ceramic Immobilization Facility (Immobilized Disposition)	$3.2 \times 10^{-8}$	$5.6 \times 10^{-11}$	$1.2 \times 10^{-17}$	$2.5 \times 10^{-14}$	$3.2 \times 10^{-8}$	$1.6 \times 10^{-14}$
Deep Borehole Complex (Direct Disposition)	$5.3 \times 10^{-9}$	$7.6 \times 10^{-11}$	$2.0 \times 10^{-17}$	$3.1 \times 10^{-14}$	$5.3 \times 10^{-9}$	$2.7 \times 10^{-15}$
Deep Borehole Complex (Immobilized Disposition)	$6.6 \times 10^{-9}$	$1.1 \times 10^{-10}$	$3.0 \times 10^{-17}$	$4.5 \times 10^{-14}$	$6.7 \times 10^{-9}$	$2.2 \times 10^{-9}$
Vitrification Facility	$1.3 \times 10^{-5}$	$8.6 \times 10^{-7}$	$2.5 \times 10^{-10}$	$1.3 \times 10^{-7}$	$1.4 \times 10^{-5}$	$4.7 \times 10^{-6}$
Ceramic Immobilization Facility (Ceramic Immobilization)	$3.6 \times 10^{-8}$	$1.7 \times 10^{-7}$	$5.1 \times 10^{-11}$	$2.8 \times 10^{-8}$	$2.3 \times 10^{-7}$	$7.7 \times 10^{-8}$
Advanced Boiling Water Reactor	$5.4 \times 10^{-3}$	$3.2 \times 10^{-1}$	$1.2 \times 10^{-1}$	$7.1 \times 10^{-3}$	$4.5 \times 10^{-1}$	$1.5 \times 10^{-1}$
CE System 80+ Reactor	$1.1 \times 10^{-2}$	$3.1 \times 10^{-1}$	$8.7 \times 10^{-3}$	$1.5 \times 10^{-4}$	$3.3 \times 10^{-1}$	$1.1 \times 10^{-1}$
[Text deleted.]						$1.7 \times 10^{-7}$
AP600 Reactor	$2.5 \times 10^{-3}$	$2.1 \times 10^{-1}$	$2.5 \times 10^{-2}$	$1.5 \times 10^{-3}$	$2.3 \times 10^{-1}$	$7.7 \times 10^{-2}$
RESAR 90 Reactor	$8.9 \times 10^{-3}$	$3.2 \times 10^{-1}$	$1.0 \times 10^{-2}$	$1.7 \times 10^{-3}$	$3.4 \times 10^{-1}$	$1.1 \times 10^{-1}$

<sup>a</sup> Individual annual natural background radiation dose is equal to 300 mrem.

<sup>b</sup> The storage facility contributes  $4.1 \times 10^{-4}$  mrem/year.

<sup>c</sup> The radiological impacts for the Upgrade Alternative are calculated based on measured releases from facilities at Hanford, RFETS, and LANL.

[Text deleted.]  
Source: HNUS 1996a.

**Table M.2.4-4. Doses and Resulting Health Effects to the Population Within 80 Kilometers of Hanford Site From Atmospheric Releases Associated With Normal Operation in 2030**

Alternative/Facility	Dose by Pathway (person-rem)				Committed Effective Dose Equivalent (person-rem)			Estimated 1-Year Fatal Cancer Risk
	Inhalation	Ingestion	Plume Immersion	Ground Shine	Percent of Background <sup>a</sup>			
No Action (Total Site)	$5.2 \times 10^{-2}$	$4.1 \times 10^{-1}$	$4.7 \times 10^{-3}$	$1.5 \times 10^{-4}$	$4.6 \times 10^{-16}$	$2.3 \times 10^{-4}$	$2.3 \times 10^{-4}$	
Upgraded Storage Facility-200 West <sup>c</sup>	$2.8 \times 10^{-5}$	$7.6 \times 10^{-6}$	$1.6 \times 10^{-13}$	$2.4 \times 10^{-10}$	$3.5 \times 10^{-5}$	$1.9 \times 10^{-8}$	$1.8 \times 10^{-8}$	
Upgraded Storage Facility-Fuels	$3.6 \times 10^{-5}$	$1.1 \times 10^{-5}$	$2.1 \times 10^{-13}$	$3.2 \times 10^{-10}$	$4.7 \times 10^{-5}$	$2.5 \times 10^{-8}$	$2.4 \times 10^{-8}$	
Materials Examination Facility <sup>c</sup>								
Consolidated Storage Facility	$1.1 \times 10^{-4}$	$2.9 \times 10^{-6}$	$4.2 \times 10^{-14}$	$8.8 \times 10^{-11}$	$1.1 \times 10^{-4}$	$5.9 \times 10^{-8}$	$5.5 \times 10^{-8}$	
Collocated Storage Facilities	$1.1 \times 10^{-4}$	$2.9 \times 10^{-6}$	$4.5 \times 10^{-14}$	$1.3 \times 10^{-10}$	$1.1 \times 10^{-4}$	$5.9 \times 10^{-8}$	$5.5 \times 10^{-8}$	
Pit Disassembly/Conversion Facility	$1.2 \times 10^{-2}$	$4.1 \times 10^{-3}$	$7.2 \times 10^{-11}$	$1.1 \times 10^{-7}$	$1.6 \times 10^{-2}$	$8.6 \times 10^{-6}$	$8.0 \times 10^{-6}$	
Pu Conversion Facility	$8.2 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3.4 \times 10^{-12}$	$7.2 \times 10^{-9}$	$8.4 \times 10^{-3}$	$4.5 \times 10^{-6}$	$4.2 \times 10^{-6}$	
MOX Fuel Fabrication Facility	$6.0 \times 10^{-3}$	$1.6 \times 10^{-4}$	$2.3 \times 10^{-12}$	$1.1 \times 10^{-8}$	$6.2 \times 10^{-3}$	$3.3 \times 10^{-6}$	$3.1 \times 10^{-6}$	
Ceramic Immobilization Facility (Immobilized Disposition)	$1.4 \times 10^{-6}$	$3.6 \times 10^{-8}$	$5.6 \times 10^{-16}$	$1.1 \times 10^{-12}$	$1.5 \times 10^{-6}$	$8.0 \times 10^{-10}$	$7.5 \times 10^{-10}$	
Deep Borehole Complex (Direct Disposition)	$2.3 \times 10^{-7}$	$5.0 \times 10^{-8}$	$8.8 \times 10^{-16}$	$1.3 \times 10^{-12}$	$2.8 \times 10^{-7}$	$1.5 \times 10^{-10}$	$1.4 \times 10^{-10}$	
Deep Borehole Complex (Immobilized Disposition)	$2.9 \times 10^{-7}$	$7.4 \times 10^{-8}$	$1.3 \times 10^{-15}$	$2.0 \times 10^{-12}$	$3.7 \times 10^{-7}$	$2.0 \times 10^{-10}$	$1.9 \times 10^{-10}$	
Vitrification Facility	$5.8 \times 10^{-4}$	$2.0 \times 10^{-4}$	$1.1 \times 10^{-8}$	$6.1 \times 10^{-6}$	$7.9 \times 10^{-4}$	$4.2 \times 10^{-7}$	$4.0 \times 10^{-7}$	
Ceramic Immobilization Facility (Ceramic Immobilization)	$1.6 \times 10^{-6}$	$3.6 \times 10^{-5}$	$2.2 \times 10^{-9}$	$1.2 \times 10^{-6}$	$3.9 \times 10^{-5}$	$2.1 \times 10^{-8}$	$1.9 \times 10^{-8}$	
Advanced Boiling Water Reactor	$2.9 \times 10^{-2}$	$2.6 \times 10^1$	$3.0 \times 10^{-1}$	$3.5 \times 10^{-2}$	$2.6 \times 10^1$	$1.4 \times 10^{-2}$	$1.3 \times 10^{-2}$	
CE System 80+ Reactor	$7.2 \times 10^{-2}$	$3.0 \times 10^1$	$4.0 \times 10^{-2}$	$9.3 \times 10^{-4}$	$3.0 \times 10^1$	$1.6 \times 10^{-2}$	$1.5 \times 10^{-2}$	
[Text deleted.]								
AP600 Reactor	$1.6 \times 10^{-2}$	$2.0 \times 10^1$	$1.3 \times 10^{-1}$	$9.6 \times 10^{-3}$	$2.0 \times 10^1$	$1.1 \times 10^{-2}$	$1.0 \times 10^{-2}$	
RESAR 90 Reactor	$5.8 \times 10^{-2}$	$2.9 \times 10^1$	$5.4 \times 10^2$	$1.1 \times 10^{-2}$	$2.9 \times 10^1$	$1.6 \times 10^{-2}$	$1.5 \times 10^{-2}$	

<sup>a</sup> Dose to the population within 80 km from natural background radiation in the year 2030 is equal to 186,400 person-rem.

<sup>b</sup> The storage facility contributes 0.047 person-rem/year.

<sup>c</sup> The radiological impacts for the Upgrade Alternative are calculated based on measured releases from facilities at Hanford, RFETS, and LANL. [Text deleted.]

Source: HNUS 1996a.

**Table M.2.4-5. Doses and Resulting Health Effects to the Maximally Exposed Individual at Hanford Site From Liquid Releases Associated With Annual Normal Operation**

Alternative/Facility	Dose by Pathway (mrem)					Committed Effective Dose Equivalent (mrem)	Percent of Background <sup>a</sup>	Estimated 1-Year Fatal Cancer Risk
	Fish Ingestion	Other Food Ingestion	Drinking Water	Boating	Swimming			
No Action (Total Site)	$5.2 \times 10^{-4}$	$4.2 \times 10^{-4}$	0	$1.1 \times 10^{-8}$	$2.1 \times 10^{-8}$	$3.2 \times 10^{-6}$	$9.5 \times 10^{-46}$	$3.2 \times 10^{-4}$
Advanced Boiling Water Reactor	$4.6 \times 10^{-3}$	$9.5 \times 10^{-5}$	0	$1.1 \times 10^{-7}$	$2.2 \times 10^{-7}$	$1.2 \times 10^{-5}$	$4.7 \times 10^{-3}$	$1.6 \times 10^{-3}$
CE System 80+ Reactor	$1.4 \times 10^{-2}$	$4.8 \times 10^{-4}$	0	$2.1 \times 10^{-7}$	$4.3 \times 10^{-7}$	$3.3 \times 10^{-5}$	$1.4 \times 10^{-2}$	$4.8 \times 10^{-3}$
AP600 Reactor	$2.2 \times 10^{-2}$	$7.9 \times 10^{-4}$	0	$2.4 \times 10^{-7}$	$4.8 \times 10^{-7}$	$3.5 \times 10^{-5}$	$2.4 \times 10^{-2}$	$7.9 \times 10^{-3}$
[Text deleted.]								
RESAR-90 Reactor	$1.5 \times 10^{-2}$	$8.9 \times 10^{-4}$	0	$2.4 \times 10^{-7}$	$4.7 \times 10^{-7}$	$2.0 \times 10^{-5}$	$1.6 \times 10^{-2}$	$5.3 \times 10^{-3}$
								$7.9 \times 10^{-9}$

<sup>a</sup> Individual annual natural background radiation dose is equal to 300 mrem.

<sup>b</sup> The storage facility does not contribute to the dose.

Source: HNUS 1996a.

**Table M.2.4-6. Doses and Resulting Health Effects to the Population Within 80 Kilometers of Hanford Site From Liquid Releases Associated With Normal Operation in 2030**

Alternative/Facility	Dose by Pathway (person-rem)					Committed Effective Dose Equivalent (person-rem)	Percent of Background <sup>a</sup>	Estimated 1-Year Fatal Cancers
	Fish Ingestion	Other Food Ingestion	Drinking Water	Boating	Swimming			
No Action (Total Site)	$1.9 \times 10^{-4}$	1.1	$1.0 \times 10^{-3}$	$6.8 \times 10^{-8}$	$2.7 \times 10^{-7}$	$1.4 \times 10^{-5}$	1.1 <sup>b</sup>	$7.3 \times 10^{-4}$
Advanced Boiling Water Reactor	$1.7 \times 10^{-3}$	$3.3 \times 10^{-1}$	$1.7 \times 10^{-3}$	$6.9 \times 10^{-7}$	$2.7 \times 10^{-6}$	$5.2 \times 10^{-5}$	$3.3 \times 10^{-1}$	$2.2 \times 10^{-4}$
CE System 80+ Reactor	$5.1 \times 10^{-3}$	1.5	$1.1 \times 10^{-2}$	$1.3 \times 10^{-6}$	$5.3 \times 10^{-6}$	$1.4 \times 10^{-4}$	1.5	$1.0 \times 10^{-3}$
AP600 Reactor	$8.7 \times 10^{-3}$	2.6	$1.9 \times 10^{-2}$	$1.5 \times 10^{-6}$	$6.0 \times 10^{-6}$	$1.5 \times 10^{-4}$	2.6	$1.7 \times 10^{-3}$
[Text deleted.]								
RESAR-90 Reactor	$5.5 \times 10^{-3}$	2.7	$2.4 \times 10^{-2}$	$1.5 \times 10^{-6}$	$6.0 \times 10^{-6}$	$8.5 \times 10^{-5}$	2.7	$1.8 \times 10^{-3}$
								$1.4 \times 10^{-3}$

<sup>a</sup> Dose to the population within 80 km from natural background radiation in the year 2030 is equal to 186,400 person-rem.

<sup>b</sup> The storage facility does not contribute to the dose.

Source: HNUS 1996a.

**Table M.2.4.1-1. Annual Atmospheric Radioactive Releases From Normal Operation of No Action at Hanford Site (curies)**

Isotope	100 Area	200 East	200 West <sup>a</sup>	300 Area	400 Area	600 Area	No Action Storage
H-3	0	0	0	11.6	2.10	0	0
[Text deleted.]							
Co-60	$5.22 \times 10^{-6}$	0	0	$1.40 \times 10^{-8}$	0	0	0
Sr-90	$5.43 \times 10^{-5}$	$1.44 \times 10^{-4}$	$8.4 \times 10^{-5}$	$4.15 \times 10^{-5}$	0	$1.80 \times 10^{-7}$	$4.4 \times 10^{-5}$
Ru-106	$1.31 \times 10^{-5}$	0	0	0	0	0	0
Sb-125	$6.01 \times 10^{-6}$	0	0	$1.51 \times 10^{-6}$	0	0	0
I-129	0	$4.85 \times 10^{-3}$	$4.0 \times 10^{-6}$	0	0	0	0
Cs-134	$8.89 \times 10^{-8}$	0	0	$3.30 \times 10^{-7}$	0	0	0
Cs-137	$1.61 \times 10^{-4}$	$1.50 \times 10^{-3}$	$2.3 \times 10^{-4}$	$9.34 \times 10^{-7}$	$8.22 \times 10^{-6}$	0	0
Pm-147	0	$1.10 \times 10^{-4}$	0	0	0	0	0
Eu-154	$6.28 \times 10^{-6}$	0	0	$1.49 \times 10^{-6}$	0	0	0
Eu-155	$2.84 \times 10^{-6}$	0	0	$2.60 \times 10^{-8}$	0	0	0
Pb-212	0	$9.70 \times 10^{-4}$	0	0	0	0	0
Rn-222	0	0	0	1.50	0	0	0
[Text deleted.]							
Pu-238	$1.03 \times 10^{-6}$	$3.20 \times 10^{-6}$	0	$6.85 \times 10^{-8}$	0	0	0
Pu-239	$8.21 \times 10^{-6}$	$1.12 \times 10^{-5}$	$3.8 \times 10^{-5}$	$8.44 \times 10^{-6}$	$2.38 \times 10^{-6}$	$4.00 \times 10^{-8}$	$5.1 \times 10^{-4}$
Pu-241	0	$3.30 \times 10^{-5}$	0	0	0	0	$3.4 \times 10^{-3}$
Am-241	$5.41 \times 10^{-6}$	$2.78 \times 10^{-5}$	$5.5 \times 10^{-6}$	$5.51 \times 10^{-8}$	0	0	$9.4 \times 10^{-5}$

<sup>a</sup> Presented releases do not include those associated with storage operations.

Source: HF PNL 1994b.

**Table M.2.4.1-2. Annual Liquid Releases From Normal Operation of No Action at Hanford Site (curies)**

Isotope	Release <sup>a</sup>
H-3	0.38
Co-60	$3.6 \times 10^{-4}$
Sr-90	0.11
Ru-106	$1.6 \times 10^{-3}$
Sb-125	$1.3 \times 10^{-4}$
Cs-134	$4.7 \times 10^{-5}$
Cs-137	$4.4 \times 10^{-4}$
Pu-239	$1.4 \times 10^{-7}$

<sup>a</sup> Total site release.

Source: HF PNL 1994b.

## M.2.4.2 Storage and Disposition

**Atmospheric Releases and Resulting Impacts to the Public.** Total site radiological impacts during operation of storage or disposition facilities can be found by adding the impacts resulting from No Action facilities to the changes in impacts resulting from storage or disposition facilities. For example, to determine the radiological impact for the addition of the AP600 reactor at Hanford, the No Action facilities doses would be summed with the AP600 reactor doses. Estimated annual atmospheric radioactive releases for the storage and disposition facilities are given in Section M.2.3. Tables M.2.4-3 and M.2.4-4 include the atmospheric radiological impacts by alternative facility.

- | The annual doses associated with the different alternative facilities range from  $5.3 \times 10^{-9}$  to 0.45 mrem to the maximally exposed member of the public and from  $2.8 \times 10^{-7}$  to 30 person-rem to the 80-km (50-mi) population in 2030. The associated health effects from annual operations are included in both tables.
- | **Liquid Releases and Resulting Impacts to the Public.** There are two disposition technologies that would release liquid discharges to the surface water surrounding Hanford. These are the large and small evolutionary LWRs. The liquid releases for these technologies are given in Section M.2.3. As an example of determining the total site liquid radiological impact associated with the addition of an AP600 reactor at Hanford, the No Action liquid doses must be summed with the AP600 reactor liquid doses. Tables M.2.4–5 and M.2.4–6 present the liquid radiological impacts for the applicable alternative facilities.

The annual doses associated with the different LWR's that have liquid releases range from  $4.7 \times 10^{-3}$  to 0.024 mrem to the maximally exposed member of the public, and range from 0.33 to 2.7 person-rem to the downstream population in 2030. The associated health effects from annual operations are included in both tables.

**Worker Doses and Health Effects.** For the storage and disposition alternatives, the impacts from the No Action facilities need to be added to the changes in impacts from the storage or disposition facilities to determine the impacts from total site operation (refer to the worker discussion under No Action, above, and to Table M.2.3.2–1).